DOI:
10.1177/0073275319842425

Document Version
Peer reviewed version

'The best and most practical philosophers': Seamen and the authority of experience in early modern science

Abstract

Within the historiography of early modern science, trust and credibility have become synonymous with genteel identity. While we should not overlook the cultural values attached to social hierarchy and how that shaped the credibility of knowledge claims, this has limitations when thinking about how contemporaries regarded the origins of that knowledge and its location in different types of workers and skillsets. Using the example of seamen in the circles of the Royal Society, this article employs the category of experience, and by extension expertise, to illustrate how recognized forms of knowledge and skill acted as routes to credibility and authority in early modern science. It argues that, within the experimental community, the seaman's authority derived from their direct experience of novel and remote phenomena and the cumulative effect of their wider experience. The accumulated experience they acquired from frequent practice, observation and exposure translated into a form of 'expertness' that rendered seamen trustworthy and credible observers and thinkers. The gentlemanly trust model does not accommodate nor acknowledge the ways the seaman's direct and accumulated experience (and that of many other professional groups) were recognized and valued in inquiry and discourse. The article therefore sets out a new model for understanding trust, credibility and authority in early modern science that can take us beyond a restrictive mono-model that locates trust in one socio-cultural category to highlight the multiple, and sometimes competing, claims to epistemological authority.

Keywords

Seamen, trust, authority, Royal Society, experience, expertise

Experience, expertness, and the question of trust

Thus Three parts *of the* World *(in Error grown!)*
'Gainst Practick-knowledge *vouch* Opinion.
Had brave Columbus *worn so poor a* Soul,
Or bold Americus *a* Brain *so* Foul,
Or Noble Cabot *of that* Temper *been,*
The Indies *to this* Day *had not been* seen[1]

Following the European 'discovery' of the Americas in the late fifteenth-century, the seaman came to stand for the power and value of empirical learning. Firstly in the Iberian context, sailors and cosmographers declared experience 'as the mother of all things' relieving the errors and fictions of ancient wisdom.[2] New knowledge was the product of new experiences and, most significantly, it was the actions of the 'ignorant Columbus' and the experience of humble seamen that had challenged the stock of classical knowledge. Almost two centuries onwards, the memory of discovery across Europe continued to emphasize the power of experience embodied in their example, especially within the sciences where the seaman came to represent, at least notionally, the empirical ideal of experimental philosophy. Robert Hooke, for instance, championed a vision of a new Columbian-inspired naturalist who 'ought, as Columbus did, freely and impartially discover what he finds', while Robert Boyle suggested that the 'informations' of

[1] John Gadbury, in Samuel Sturmy, *The Mariner's Magazine* (London: 1669), n.p.
[2] Martín Fernández de Enciso, *Suma de geographia* (Seville: 1519), epilogue.

Columbus and his 'ordinary seamen' were far more reliable than 'a hundred school-philosophers, for they were able to 'inform men of a hundred things that they would never have learn'd by Aristotle's philosophy or Ptolemy's geography.' Boyle championed experience as the true means to know and discover the natural world and, consequently, its creator, making a striking comparison between Christ and the apostles, those who were 'eye witnesses and ministers of the things they speak of', and the 'navigators and travellers to America' who had directly experienced the 'state of that new world.'[3]

While this was not the violent overthrow of knowledge that older accounts have suggested, experience became a new authoritative standard within the experimental communities of early modern Europe, providing a level of authority previously supplied by classical texts.[4] This was a new form of experience, as Peter Dear has argued, for it was not a general statement about the behavior of the natural world in the Aristotelian sense, but a 'single historical occurrence' defined in time and space that could be used to support a knowledge claim. As Lorraine Daston and Elizabeth Lunbeck have demonstrated, observation and experiment became highly contrived and disciplined forms of experience, 'both designating recourse to experience as opposed to rationalist systems.'[5] Experience, however, had multiple and complex, meanings across early modern science and society. Boyle himself outlined three different forms: personal, historical, and theological. Personal experience was that 'which a man acquires immediately by himself, and accrues to him by his own sensations', whereas historical experience was a 'relation, or testimony, whether immediately or mediately, conveyed to us' that was formerly 'personal in some other man.' Theological experience referred to that which 'God is pleas'd to relate to declare concerning himself', being the third means of experience to understand the natural world.[6]

The categorization of experience, however, can be taken even further when we consider experience not just as an epistemological process, but as a source of epistemological authority. In her linguistic analysis of the term, Anna Wierzbicka distinguished between two modes of experience, which I shall refer to as 'direct experience' and 'accumulated experience'.[7] Firstly, experience could denote an act of perception, a sensory moment as Boyle described above, but it could also refer to a collected body of experience that generated or signaled a level of knowledge or know-how. Singular direct experiences are founded, to varying extents, on prior

---

[3] Robert Hooke, 'Of the true method of building a solid philosophy', in Richard Waller (ed.) *The Posthumous Works of Robert Hooke* (London: 1705), pp. 20-1; Robert Boyle, *The Christian Virtuoso* (London: 1690), pp. 75-7.

[4] For instance, see Robert Bolgar's *The Classical Heritage and its Beneficiaries* (Cambridge: Cambridge University Press, 1954) and Robert Mandrou's *From humanism to science*, trans. Brian Pearce (Harmondsworth: Penguin, 1978). Recent scholarship points to the overlap of textual and empirical traditions, showing that the shift from text to experience was not as linear as traditional accounts have suggested. For more on this, see Anthony Grafton, *Defenders of the Text: The Traditions of Scholarship in an Age of Science 1450-1800* (Cambridge: Harvard University Press, 1994); *New Worlds, Ancient Texts: The Power of Tradition and the Shock of Discovery* (Cambridge: Harvard University Press, 1995); Gianna Pomata and Nancy Siraisi (eds.), *Historia: Empiricism and Erudition in Early Modern Europe* (Cambridge: MIT Press, 2005).

[5] Peter Dear, 'Totius in verba: Rhetoric and authority in the early Royal Society,' *Isis* 76, no. 2 (1985): 144-61, 154; Lorraine Daston and Elizabeth Lunbeck (eds.), *Histories of Scientific Observation* (Chicago: University of Chicago Press, 2011), p. 13. Also on experience, see Peter Dear, *Discipline and experience: The mathematical way in the scientific revolution* (Chicago: University of Chicago Press, 1995) and Richard Yeo, *Notebooks, English Virtuosi, and Early Modern Science* (Chicago: University of Chicago Press, 2014), chapter 3.

[6] Boyle, *The Christian Virtuosi*, p. 56 (note 3).

[7] Anna Wierzbicka, *Experience, Evidence, and Sense: The hidden cultural legacy of English* (Oxford: Oxford University Press, 2010), p. 31.

knowledge generated through repeated practice in a particular domain. This is akin to Pamela Smith's idea of embodied knowledge, the notion that certain practices are 'digested many times and many times spat out.'[8] Yet accumulated experience should not to be automatically aligned with manual workers, but to the store of experience – possessed by anyone – that could, eventually, amount to some form of expertise. Failure to grasp the distinctions between these modes of experience, and to bring them together into an integrated category of analysis, has resulted in a disconnect between our understanding of the authority of experience in fact-making and the existing historical consensus on *who* was considered authoritative in the world of experimental philosophy.

If experience was the new authority, and that experience belonged to an individual or set of individuals, then the integrity of the individual was integral to assessing the integrity of the knowledge claim. This has been formulated into a question of trust, which for the last twenty years has dominated the historiographical conversation surrounding the social processes of knowledge-making. This has been largely the result of Steven Shapin's influential thesis on the relationship between truth-telling and gentle identity, which showed how codes of gentlemanly behaviour, especially the disinterestedness derived from their financial independence, were transferred into the experimental community.[9] Indeed, the long-standing emphasis on the disinterestedness of the gentleman has led to the assumption that trust was not habitually extended to those of non-genteel-status. Unlike the earnest gentleman who harbored no material interest, these men - merchants, tradesmen, seamen and other manual workers - were considered a baser sort of people motivated more by the fruit, rather than the light of knowledge. In *Social History of Truth* (1994), Shapin used Boyle's interactions with divers to highlight the issues of trust arising from non-gentle informants, yet Boyle's discrediting of divers' reports emerged from a whole host of issues that went beyond estimations of the diver's greed and self-interest. Boyle's skepticism often arose when testimony did not conform to accepted models of understanding, a result of the philosophers' own (scholarly) self-interest, and fed into wider reservations about the general limits of human experience underwater where the senses were impaired by the severe water pressure.[10] Most significantly, in the wider body of Boyle's work, Boyle often sorted testimony according to the knowledgability and skill of those who provided it, rejecting accounts not because they originated from self-interested, low-ranking informants, but because they were made by 'persons void of curiosity and skill to make such observations.'[11]

Shapin's work has done much to solidify the connection between gentlemen and trust in the historiography of early modern science, yet his work actually identified a total of seven maxims for determining credible testimony, which he deduced from seventeenth-century conduct literature. Most of these related to the nature of the testimony itself and only two of these referred to the actual sources of testimony: testimony from 'sources of acknowledged integrity and

---

[8] Pamela H. Smith, *The Body of the Artisan: Art and Experience in the Scientific Revolution* (Chicago: University of Chicago Press, 2004), p. 114.

[9] Steven Shapin, *A Social History of Truth: Civility and Science in Seventeenth-Century England* (Chicago: University of Chicago Press, 1994). Also see Steven Shapin and Simon Shaffer, *Leviathan and the Air Pump: Boyle, Hobbes, and the Experimental Life* (Princeton: Princeton University Press, 1985).

[10] On the fallibility of the senses, see Simon Schaffer, 'Self evidence,' *Critical inquiry* 18, no. 2 (1992): 327-362 and Shapin, *A Social History of Truth,* p. 219, 265-6 (note 9).

[11] Robert Boyle, 'New Experiments about the Differing Pressure of Solids and Fluids,' in *The Works of the Honourable Robert Boyle*, vol. 3 (London: 1772), p. 647; Shapin, *The Social History of Truth,* pp. 258-66 (note 9).

disinterestedness' and testimony from 'knowledgable and skilled sources.'[12] Shapin's work focuses on the former, on the integrity and disinterestedness of the Restoration gentleman, though much remains to be said on how the knowledge and skill of informants could act as an alternative criteria for establishing trust and authority. Work by Barbara Shapiro and Palmira Fontes da Costa has already suggested that social identity was just one of many other significant factors alongside skill and occupation that could determine the credibility of an individual.[13] Trust is 'a system of expectation', yet this expectation could derive from a shared belief in recognized forms of knowledge, skill and experience as much as it could derive from the socio-cultural identity of actors.[14] While we should not overlook the cultural values attached to social hierarchy and how that shaped the credibility of knowledge claims, this has its limitations when thinking about the ways contemporaries regarded the origins of that knowledge and its location in different types of individuals and skillsets. If a gentleman was considered trustworthy and his relations credible, this did not preclude the credibility of other relators or groups, nor did it translate into any overarching authority.

Expertise is a useful category to consider the ways knowledge and skill, as types of accumulated experience, acted as routes to authority. It is commonly suggested that the term 'expertise' did not exist in the seventeenth century, but this overlooks an equivalent word in seventeenth-century English: 'expertness'.[15] 'Expertness' was a translation of the French 'expertise' and was variably defined as 'skillfulness' or being 'much experienced in things.' Indeed, so central was experience to 'expertness' that John Wilkins defined 'inexpert' as a synonym for 'inexperience' in his universal philosophical language.[16] As an actors' category, expertness then allows us to root our understanding of expertise in the seventeenth century, standing as testament to the empirical associations, and origin, of the concept in the early modern

[12] Shapin, *A Social History of Truth*, p. 212 (note 9).

[13] Barbara Shapiro, *A Culture of Fact: England, 1550-1720* (Ithaca: Cornell University Press, 2000); Palmira Fontes da Costa, 'The making of extraordinary facts: authentication of singularities of nature at the Royal Society of London in the first half of the eighteenth century,' *Studies in the History and Philosophy of Science* 33, no. 2 (2002): 265-88. Also see Harold Cook and David Lux, 'Closed circles or open networks?: Communicating at a distance during the Scientific Revolution,' *History of Science* 36 (1998): 179-211; Charles Withers, 'Reporting, Mapping, Trusting: Making Geographical Knowledge in the Late Seventeenth century,' *Isis* 90, no. 3 (1990): 497-521; Julia Schleck, 'Forming Knowledge: Natural Philosophy and English Travel Writing' in Judy A Hayden (ed.) *Travel Narratives, the New Science, and Literary Discourse 1569-1750* (Farnam: Ashgate, 2012), pp. 53-69.

[14] Shapin, *A Social History of Truth*, p. 8 (note 9).

[15] On the history of expertise, particularly in the early modern and/or naval context, see Eric H. Ash (ed.), 'Expertise: Practical Knowledge and the Early Modern State', *Osiris* 25 (2010), p. 5; Peter Dear, 'Mysteries of State, Mysteries of Nature: Authority, Knowledge and Expertise in the Seventeenth Century' in Sheila Jasonoff (ed.) *States of Knowledge: The Co-Production of Science and Social Order* (London: Routledge, 2004), pp. 206-224; Christelle Rabier (ed.), *Fields of Expertise: A Comparative History of Expert Procedures in Paris and London, 1600-present* (Cambridge: Cambridge Scholars Publishing, 2007); Don Leggett and James Davey, 'Introduction: expertise and authority in the Royal Navy, 1800-1950,' *Journal for Maritime Research* 16, no. 1 (2014): 1-13; William Ashworth, 'Commentary: expertise and authority in the Royal Navy, 1800-1950,' *Journal for Maritime Research* 16, no. 1 (2014): 103-116.

[16] Also translated as 'habilité' (ability) in French. Robert Cawdrey, *A Table Alphabeticall conteyning and teaching the true writing, and understanding of Hard Usual English Words* (London:1604); Randle Cotgrave, *A Dictionary of the French and English Tongues* (London: 1611); Guy Miege, *A New Dictionary French and English* (London: 1677); Guy Miege, *A dictionary of barbarous French* (London: 1679). Miege translates the French 'expertise' as 'expertness' and 'skillfulness.' In Samuel Johnson's 1755/6 dictionary, 'expertness' was defined as 'skill, readiness' and derived from 'expert', which was taken as 'skillful, addressful, intelligent in business', 'ready; dexterous', and 'skillful by practice or experience.' John Wilkins, *An Essay Towards a Real Character and a Philosophical Language* (London: 1668), p. 205.

period. It must, however, be pointed out that its usage was not as widespread as its sister term 'expert', which had the same linguistic origins. As recent accounts of early modern expertise have shown, 'expert' was used as an adjective, not a noun, and so we are here concerned with the quality of being expert (or 'much experienced'), not the figure of the 'expert' per se. This is an important distinction if we are to avoid investing modern meaning into the term, for the question of who counted as 'expert' in the seventeenth century was not settled. As Eric Ash articulates, 'to be expert was to possess and control a body of specialised practical or productive knowledge, not readily available to everyone', though this did not mean that expertise in a particular subject came in one form, or that it was located in one place.[17] Indeed, it may be productive to start thinking about expertise as different types of accumulated experience competing for legitimacy and authority. Through recognizing this and the explicit semantic connection between expertness and experience, we can begin to determine the authority attached to different forms of experiential knowledge, uniting the social identity of practitioners with the origins of the knowledge they espoused.

Given the unique make-up of expertness in different professional groups, or indeed individuals, we need to turn to specialized case studies to ascertain how certain skillsets were valued and assessed. Seamen offer an interesting case study to consider how the direct and accumulated experience of sources could translate into estimations of trust and authority. Firstly, the maritime sphere was an important culture of knowledge where information and skills were imparted, exchanged, and circulated on a global scale and, as a result, maritime culture has started to occupy an important place in the vibrant scholarship surrounding the participation of low-status manual workers in scientific inquiry.[18] However, efforts to place seamen amongst this diverse cast of characters, encompassing technicians, slaves, craftsmen and artists, highlight the complexity of this field. The work of Pamela Smith and Pamela Long, for instance, has made a substantial contribution to our understanding of these workers and their empirical ways of working with nature and its materials.[19] From goldsmiths to glassmakers, painters to sculptors, they focus on artisans who worked in a creative or artistic capacity, yet even within this wide-ranging typology, the emphasis on makers has left a smaller space to consider other manual workers, like seamen, who do not fit the conventional artisan mold. Blowing a vase or assembling a clock mechanism was different from navigating a ship or putting up the rigging.

Seamen were not artisans who 'work[ed] with their hands in craft production'; they steered, rigged, built, cleaned, maintained, observed, planned, calculated, managed, and directed. Like most workers, their activity cannot be simply explained via the *episteme/techne* divide, for their work was a complex zig-zag between different forms of knowledge and skills, which were located

---

[17] Eric H. Ash, 'Introduction: Expertise and the Early Modern State', in 'Expertise: Practical Knowledge and the Early Modern State', *Osiris* 25 (2010), p. 5.

[18] For instance, see Henrique Leitão and Antonio Sánchez, 'Zilsel's Thesis, Maritime Culture, and Iberian Science in Early Modern Europe,' *Journal of the History of Ideas* 78, no. 2 (2017), pp. 191-210. Margaret Schotte's forthcoming monograph on early modern navigators seeks to highlight the wider contribution of seamen to early modern science (*Sailing School: Navigating Science and Skill*, John Hopkins University Press, forthcoming).

[19] Smith, *The Body of the Artisan*; Pamela O. Long, *Artisan/Practitioners and the Rise of the New Sciences, 1400-1600* (Corvallis: Oregon State University Press, 2011). Also see Steven Shapin, 'The Invisible Technician', *American Science* 77, no. 6 (1989), pp. 554-563; Londa Schiebinger, *Plants and Empire: Colonial Bioprospecting in the Atlantic World* (Cambridge, MA: Harvard University Press, 2007), and Charles Withers, 'Reporting, Mapping, Trusting: Making Geographical Knowledge in the Late Seventeenth century', *Isis* 90, no. 3 (1990), pp. 497-521.

in different types of maritime practitioner. One way of actually moving past this dichotomy is by returning to the Aristotelian division of knowledge and visualizing the relationship between different forms of activity. From the primary categories of *theoria* (theory), *poesis* (production), and *praxis* (action) come the virtues of *episteme* (knowledge), *techne* (craft/art), and *phronesis* (practical wisdom), respectively.[20] The distinction between *theoria/episteme,* on the one hand, and *poesis/techne*, on the other, is well observed in the historiography of science, having been (problematically) distilled into the basic opposition of theory and practice, yet this important third element - *praxis*/*phronesis* - has been significantly overlooked. What is interesting here is the distinction between *poesis* and *praxis*, for in the Aristotelian tradition *techne* was aligned specifically with *poeis* (production), not *praxis* (action). In a sense, *phronesis* operated between *episteme* and *techne*, for it involved both thinking and doing (it was wisdom gained from experience). This helps collapse the boundary between thought and action, and head and hand, and can potentially open up the historiographical categories surrounding the different sorts of workers, and their associated modes of experience and expertise, involved in the development of the sciences. The distinction between *poesis* and *praxis*, those with the goal of production and those with the goal of action, is therefore useful in opening up the category of the artisan/practitioner to consider skilled labourers, such as miners, husbandmen and indeed seamen, who operated outside the workshop.

The term 'seamen' itself is a capacious category that obscures the multiple roles aboard a ship and I am here defining them as seafarers from across the socio-economic spectrum. Many commissioned posts in the navy still belonged to gentlemen, but what is interesting here is that this was rarely emphasized by experimenters, suggesting that the maritime informants they encountered were either of non-genteel status, or that this was simply immaterial to the establishment of the seaman's authority. In fact, the question of civility versus experience finds an interesting parallel in the naval sphere as we see it reflected in the long-standing debate between the commission of gentlemen and tarpaulin officers.[21] For reasons of honor, military prowess, and the need to maintain the loyalty of the gentry, the commission of gentlemen was often favored over tarpaulins, who were typically of lower social origin, but who had greater seafaring experience and were the mainstay of mercantile shipping. Yet a number of naval administrative reforms in the late-seventeenth century signaled the increasing importance attached to the value of experience in senior postings: the 1661 'volunteer per order' system, for instance, sought to transform gentlemen into tarpaulins by giving them a practical foundation in the nautical arts, and, in 1677, a minimum sea-service requirement and a practical examination

[20] In *Nichomachean Ethics,* Aristotle outlined *theoria, poiesis,* and *praxis* as three key human activities (thinking, making, doing). He distinguishes *poiesis,* and *praxis* (and, by extension, the associated virtues of *techne* and *phronesis*) as follows: 'action and making are different kinds of thing, since making aims at an end distinct from the act of making, whereas in doing, the end cannot be other than the act itself' (Book 6, chapter 5[1140b 1-5]). For more on these concepts see Oded Balaban, 'Praxis and Poesis in Aristotle's practical philosophy,' *The Journal of Value Inquiry* 24, no. 3 (1990): 185-98 and Richard Parry, 'Episteme and Techne', The Stanford Encyclopaedia of Philosophy (Fall 2014 Edition): https://plato.stanford. edu/entries/episteme-techne/ (10 July 2018).

[21] On gentlemen versus tarpaulins, see J.D. Davies, *Gentlemen and tarpaulins: The officers and men of the restoration navy* (Oxford, Oxford University Press, 1991); Norbert Elias, *The Genesis of the Naval Profession*, ed. René Moelker and Stephen Mennell (Dublin: University College Dublin Press, 2007).

for entering lieutenants were introduced.[22] What we see in the naval context is almost an inversion of Shapin's argument about the importance of gentlemanly virtue, for many in the administration, especially Samuel Pepys who operated at the intersection of learned and naval circles, questioned the gentleman's emphasis on honour and etiquette and thus their fitness to command at sea on the basis of civility alone.

In this article, I intend to elaborate on 'experience', both direct and accumulated, as another important criteria for establishing trust and credibility in early modern science, one that is more inclusive of the multiple claims to epistemological authority than the gentlemanly trust model. This article argues that, within the experimental community, the seaman's authority derived from their direct experience of novel and remote phenomena and the long-term accumulation of that experience, which amounted to a form of 'expertness'. It therefore highlights the significance attached to different modes of experience and how this facilitated participation in the processes of knowledge-making. The emphasis on expertness still meant that the system of knowledge production remained hierarchical, but this operated on the basis of skill rather than status. Through experimenting, observing, and witnessing natural phenomena, experience was the chief means by which experimental philosophers established matters of fact, but it was also the route by which highly skilled, non-genteel individuals could participate in that community. Experience was the key facilitator, expanding both the epistemological and social parameters of early modern science.

Seamen and the geography of personal experience

In the preface to *A New Voyage round the* world, the infamous buccaneer William Dampier justified his relation of foreign lands, and its dedication to the Royal Society, by emphasizing the novelty of his experience: 'as the scene of them is not only remote, but for the most part little frequented also, so there may be some things in them New even to you.'[23] 'One who rambles about a Country,' he continued 'can give usually a better account of it, than a Carrier who jogs on to his Inn, without ever going out of his Road.' The peculiarity of Dampier's experience and the ways in which it was geographically defined became the foundation of his authority. Some scholars have highlighted the 'narrative of reformation' in Dampier's texts, where his piratical past is softened for a learned, polite audience, but even the suspected editorial interventions of Hans Sloane point to the overriding significance of Dampier's direct contact with the phenomena he reported on.[24] Indeed, in a review of *New Voyage* in the *Philosophical Transactions*, it was remarked that Dampier's 'opportunity of visiting many ports and places, scarcely described in any voyages' had made him 'more diligent in his observations, and more particular in his descriptions.'[25] As Philip Edwards has shown, the revisions to Dampier's original text mostly

[22] For more on this see J.D. Davies, *Pepys's Navy: Ships, Men and Warfare 1649-89* (Barnsley: Seaforth Publishing, 2008), chapter 14; Evan Wilson, Jakob Seerup and Anna Sara Hammar, 'The education and careers of naval officers in the long eighteenth century: an international perspective,' *Journal for Maritime Research* 17, no. 1 (2015): 17-33.
[23] William Dampier, *A New Voyage Around the World* (London: 1697), p. A2.
[24] On Dampier's narrative of reformation, see Anna Neill, *British Discovery Literature and the Rise of Global Commerce* (Basingstoke: Palgrave Macmillan, 2002); Anna Neill, 'Buccaneer Ethnography: Nature, Culture, and Nation in the Journals of William Dampier,' *Eighteenth-Century Studies* 33, no. 2 (2000): 165-80; and William Hasty; 'Piracy and the production of knowledge in the travels of William Dampier, c. 1679-1688,' *Journal of Historical Geography* 37 (2011): 40-54.
[25] 'An account of a book', *Philosophical Transactions* 19 (1697): 426-40.

related to expansion of geographical or ethnographic description that could have only derived from eye witness material.[26]

Seamen like Dampier had become the eyes for a whole experimental community, bringing alive foreign places that were scarcely frequented by the metropolitan experimental philosopher. Robert Knox, the East India Company merchant who penned *Historical Relation of Ceylon,* was lauded by Hooke for transporting 'a whole kingdom...in his head', while Basil Ringrose's *Bucaniers of America,* which mixed adventure with natural history, was similarly distinguished due to its relators 'having been not only eye-witnesses, but also actors in the transactions they report', again emphasizing 'the novelty of their exploits.'[27] The necessity for geographically dispersed witnesses manifested itself in the various forms of travel instruction issued by the Royal Society in its early years. The chief of these was the 'Directions for Seamen bound for far voyages', which drew on the quotidian experience of English seamen, who were requested to record tides, winds, storms; draught, plot and sound coastlines; and observe the declination of the compass. Now the fact that seamen were specifically sought to conduct these inquiries is only surprising if we continue to equate trust and credibility with gentlemanly virtue and ignore the authority of experience in the experimental community. Given the emphasis on witnessing in the circles of experimental knowledge-making, seamen were, in many ways, the obvious choice of informant.[28] They had frequent opportunity to observe maritime phenomena, expanding geographies of experience and increasing the Royal Society's 'philosophical stock by the advantage, which England enjoys of making voyages into all parts of the world.'[29]

As with other forms of travel instruction, the 'Directions' disciplined the experience of the observer by 'calling for only simple, perceptible facts'.[30] If geographies of experience were to

---

[26] Philip Edwards, *The Story of the Voyage: Sea Narratives in Eighteenth-century England* (Cambridge: Cambridge University Press, 2004), pp. 27-8. On Sloane's interventions and the editing process, see James Kelly, 'Bordering on Fact in Early Eighteenth Century Sea Journals', in Dan Doll and Jessica Munns (eds.) *Recording and Reordering: Essays on the seventeenth- and eighteenth century Diary and Journal* (Lewisburg: Bucknell University Press, 2006), pp. 158-84, 171-2; Hasty, 'Piracy and the production of knowledge in the travels of William Dampier', p. 46 (note 23).

[27] Robert Knox, *An Historical Relation of Ceylon* (London: 1681), preface; Basil Ringrose, *Bucaniers of America the second volume* (London: 1685), preface. There is evidence to suggest that Hooke was involved in bringing Ringrose's account to publication. Included in Hooke's manuscript collection of sea journals is a copy of Ringrose's relations and, at the bottom of the script, the words: 'Publish pt & an extract of the rest' (London Metropolitan Archives, CLC/495/MS01757, 'A Journal into the South Seas by Basil Ringrose 1685').

[28] On the importance of eye-witnessing, see Steven Shapin, 'Pump and Circumstance: Robert Boyle's Literary Technology', *Social Studies of Science* 14, no. 4 (1984), pp. 481-520.

[29] 'Directions for seamen, bound for far voyages,' *Philosophical Transactions* 1 (1665): 140-3. The 'Directions' were devised by Lawrence Rooke, Fellow of the Royal Society, in 1662 and several manuscript copies were made by the Royal Society to distribute to fellows about to embark on long voyages. The 'Directions' were subsequently printed in the first volume of the *Philosophical Transactions* with a short introduction, presumably written by Oldenburg as editor. This was followed by an 'An Appendix to the Directions for Seamen' in the next issue that described the contrivance of new nautical instruments devised by Robert Hooke, which had recently been trialed in the River Thames. In 1667, a significantly enlarged edition of the 'Directions for seamen' was printed 'with ample and particular explanations', integrating the account of Hooke's nautical instruments ('Directions for observations and experiments to be made by masters of ships, pilots, and other fit persons in their sea-voyages,' *Philosophical Transactions* 2 [1667]: 433-48).

[30] On the design of travel instructions, see Jason Pearl, 'Geography and Authority in the Royal Society's Instructions for Travelers', in *Travel Narratives, The New Science and Literary Discourse, 1569-1750*, pp. 71-86; and Daniel Carey, 'Compiling Nature's History: Travellers and Travel Narratives in the Early Royal Society,' *Annals of Science* 54 (1997): 269-92. On the wider geographical and historical context of standardized questionnaires, especially relating to Spain and the Casa de Contratacion, see Antonio Barrera-Osorio, 'Empire and knowledge: Reporting from the New World', *Colonial Latin American Review* 15, no. 1 (2006): 39-54; Antonio Barrera-

expand, if the collection of data on a global scale was to eventually bring forth new doctrines and principles, then the direct experience of various observers needed to be made commensurate. Instructions trained the eyes how to see and forms and instruments provided 'templates for standardization', distilling experience into numbers and matters of fact that could be compared, contrasted, and collated.[31] Boyle had more generally argued that inquiries should include 'proposals of ways to enable men to give answers to these more difficult inquiries' and the 'Directions' themselves illustrate this kind of enabling process, which worked to facilitate participation in information-gathering initiatives.[32] The 'Directions' should then be understood as a form of didactic literature that aimed 'to better capacitate [seamen] for making such observations.'[33] They sought to draw on and perfect seamen's skills, mobilising their potential as observers and disciplining their experience for philosophical ends. In the second, expanded edition of the 'Directions', seamen were not only told what to observe, but how to observe it: they were told to observe weather and tidal changes, but they were also instructed how to mark and register these changes carefully; they were told to measure the depth of the sea with new sounding devices, but they were also instructed how to assemble and operate these instruments, being invited to visit Gresham College to acquire these instruments and be instructed in the use of them.

Seamen, like any set of informants, were credible in number and the emphasis on corroboration required the repetition of observations and experiments at different times and places. It was widely held that a higher number of corroborating accounts translated into a higher degree of certainty, an idea that was demonstrated mathematically in an anonymous article on the 'Calculation of the credibility of Human Testimony' in Edmond Halley's *Miscellanea Curiosa*.[34] It was the opinion of the Royal Society secretary, Henry Oldenburg, that in the distribution of inquiries ''tis altogether necessary, to have confirmations of the truth of these things from several hands, before they be relied on.'[35] This sentiment was shared by many, including Halley, who argued that investigation into the trade winds was 'not the work of one, nor of few, but of a multitude of Observers to bring together the experience requisite to compose a perfect and complete History.'[36] This was the sort of history that the 'Directions' intended to make possible. Asked to observe the declination and variation of the compass, seamen were instructed to do so 'in as many places as they can, and in the same places, every single voyage.' Observations of the tides were required 'in as many places as may be'; precise times of the 'flood

---

Osorio, *Experiencing nature: The Spanish American empire and the early scientific revolution* (Austin: University of Texas Press, 2010); and Alison Sandman, 'Spanish Nautical Cartography in the Renaissance', in David Woodward (ed.) *The History of Cartography, Volume 3: Cartography in the European Renaissance* (Chicago: University of Chicago Press, 2007), pp. 1095-1142.

[31] See Joan-Pau Rubiés, 'Instructions for travellers: teaching the eye to see', *History and Anthropology* 9, no. 2-3 (1996), pp. 139-190 and Marie Noëlle Bourguet, Christian Licoppe, and H. Otto Sibum (eds.), *Instruments, travel and science: itineraries of precision from the seventeenth to the twentieth century* (London: Routledge, 2003), introduction.

[32] Robert Boyle, 'The General History of the Air', in *Works*, vol. 5, pp. 734-5 (note 11)

[33] 'Directions for seamen', p. 141; 'Directions for observations and experiments', p. 434 (note 27).

[34] 'Calculation of the credibility of Human Testimony', in Edmond Halley (ed.), *Miscellanea Curiosa*, vol. 2 (London 1706), pp. 1-8. One of John Locke's maxims for the evaluation of testimony was also the multiplicity of accounts, see John Locke, *Essay concerning Human Understanding* (London:1690), book VI, chapter 15.

[35] 'Inquiries for Suratte, and other parts of the East Indies', *Philosophical Transactions* 2 (1666): 415-22, 415.

[36] Edmond Halley, 'A Historical Account of the Trade Winds and Monsoons observable in the Seas between and near the Tropicks,' *Philosophical Transactions* 16 (1686): 153-68, 162.

and ebb' were to be recorded in all rivers, bays, capes and harbours and notes to be made on the nature of tides at different times of the year. The situation of dangerous rocks, channels, and passages were to be recorded 'in all places' and a register was to be kept 'of all changes of wind and weather at all hours by night and by day.' It was expected that these observations and experiments were to be repeated on every new voyage and so 'from [these] multitudes of Experiments and Observations, such rules may be framed, as may be of inestimable use.'[37] The 'Directions' recommended that each experiment was to be repeated every new voyage, 'the multitude and frequency of them being necessary for finding out and confirming the truth of them.'[38]

In one sense, the 'Directions' could be interpreted as a necessary, even regrettable, arrangement in circumstances where experimental philosophers were unable to observe phenomena themselves. Yet, to some degree, this was to be expected in an empirical culture that privileged one's own personal experience over the secondary accounts of others (any others). As Boyle explained, 'I must either make use of other men's testimonies or leave some of the remarkablest phenomena...unmentioned'.[39] Furthermore, the term 'Directions' suggests something more facilitative than conventional forms of travel instruction. Most other instructions issued by the Royal Society were labeled as 'inquiries', not 'directions', and Oldenburg distinguished between the two as distinct forms. As their names implied, 'inquiries' often consisted of a diverse set of specific questions limited only by geographic boundaries – 'of things observable in foreign countries' - usually with the aim to confirm or reject existing accounts. This was a similar mode of fact-checking to Thomas Browne's *Pseudodoxia Epidemica* (1646), which pursued 'enquiries into very many received tenets and commonly presumed truths' to eliminate erroneous thinking about the natural world. The 'Directions', on the other hand, were something rather different; they were not questions, but directives to collect raw data on different natural phenomena, 'on the particulars they desire chiefly to be informed about.' This involved making, rather than checking facts, requiring precise measurement, efficient and accurate recording, and the skillful handling and construction of new instruments. This made the programme set out in the 'Directions' arguably more central to the experimental process – of making new facts and generating new rules – than the enquiries distributed to other types of traveler.

The direct experience of seamen acted as a source of their authority to speak on foreign and strange natural phenomena, an experiential privilege they had acquired through travel. However, experience, as an analytical category, enters a different guise when we consider the ways in which direct experiences were accumulated and how this converted into recognized forms of skill or expertness. Seamen were more than necessary extensions of the senses in extreme cases of data collection. The targeting of seamen in the search for maritime particulars meant that specialist knowledge was desirable in the observer.[40] Seamen were targeted because their experience entailed something more than direct contact with nature; it was their accumulated experience of the maritime environment, their expertness, that rendered them ideal observers of this sort of

[37] 'Directions for observations and experiments', pp. 434-5, 438, 439, 444, 448 (note 27).
[38] 'Directions for observations and experiments', p. 448 (note 27).
[39] Robert Boyle, *New Experiments and Observations Touching Cold, or an Experimental History of Cold* (London: 1664), C7r.
[40] We also see this in the case of husbandmen and agriculture, where 'those who are skillful in husbandry [were] publically invited to impart their knowledge herein, for the common benefit of their country' ('Enquiries concerning agriculture', *Philosophical Transactions* 1 [1665], pp. 91-4).

phenomena. This is a situation that can also be seen in the recruitment of tidal observers in the *Philosophical Transactions*, where the initial advertisement for 'understanding persons' of a non-descript background turned into a preference for those with greater experience of the seas and coastlines. Like the 'Directions', Robert Moray's tidal inquiries developed the epistemic tools for recording and standardizing measurements, including a 'pattern' or template for a tide table to record tidal observations.[41] Moray corroborated his own observations, recorded off the west coast of Scotland, with the experience of local residents whose status as 'islanders' indicated a certain expertness in maritime knowledge:

> The Gentleman, to whom the island belongs at present, and divers of his brothers and friends, knowing and discreet persons, and expert in all such parts of sea-matters, as other islanders commonly are.[42]

When it came to establishing the credibility of his informants, Moray placed greater emphasis on the islanders' expertness (a result of their frequent exposure to the seas) than the character of the gentleman. Similarly, John Wallis, when developing his theory of the tides, relied on the observations of the residents of Romney Marsh, who frequently experienced the effects of the tides. In fact, Wallis actually attributed the veracity of the inhabitant's relations to their self-interest; their livelihood depended on grazing or feeding sheep and so they were consequently 'very vigilant and observant, at what times they are most in danger of having their lands drowned.'[43] Wallis also promoted the use of water-men to observe the tides, but it was the testimony and experience of the seaman that he privileged over all observers by means of their expertness on coastal and open waters; 'the judgement of seamen [being] more considerable than that of the [regular] inhabitants.'[44]

The 'Directions' appear to follow Boyle's general prescription that inquiries should be devised which 'require learning or skill in the answerer.'[45] Instead of addressing the generic seaman (or indeed any other traveler), the second, expanded edition of the 'Directions' explicitly targeted the masters and pilots of ships, those who were responsible for navigation and who could be said to possess specialist skills. In his lectures on navigation, Hooke also made an important distinction between masters and pilots, on the one hand, and the mariner and steersman, on the other. He declared that he would not meddle with the 'mechanical part' of the mariner, the actual practice of moving and guiding the ship, but concerned himself with the 'theoretical part which is proper to the pilot and master, who directs the steers man what course to take.'[46] The specific appeal to masters and pilots over the higher commissioned naval offices of lieutenant and captain indicates the epistemic value of experience and skill over rank and status. This was further

---

[41] Robert Moray, 'Patterns of the tables proposed to be made for observing tides,' *Philosophical Transactions* 1 (1665): 311-13.

[42] Robert Moray, 'A relation of some extraordinary tides in the West-Isles of Scotland,' *Philosophical Transactions* 1 (1665): 53-5.

[43] John Wallis, 'An essay of Dr John Wallis, exhibiting his hypothesis about the flux and reflux of the sea', *Philosophical Transactions* 1 (1665): 263-81, 276.

[44] Royal Society (RS), London, EL/W1/104, Wallis to Oldenburg, 19 March 1669/70. RS, EL/W1/28, Wallis to Oldenburg 18 August 1666. Also published in Rupert Hall and Marie Boas Hall (eds.), *The Correspondence of Henry Oldenburg*, vols. 3 and 6 (Madison: The University of Wisconsin Press, 1966-9).

[45] Boyle, 'The General History of the Air' in *Works,* vol. 5, pp. 734-5 (note 11).

[46] Hooke, 'Lectures concerning Navigation and Astronomy', in *Posthumous Works*, p. 452.

emphasized by the fact that officials at Trinity House (England's piloting body), not the Royal Society, were to distribute the 'Directions' to 'as many ingenious persons, as have opportunity' and, in particular, determine which seamen were considered 'fit for performance.'[47] The selection of seamen was rooted in maritime standards of good seamanship. The 'Directions' were not designed to be distributed to those who had the simple opportunity to observe, but to those with the skills to do so.

On the institutional level of the Royal Society, the 'Directions' delineate the central role of seamen in expanding geographies of experience and the ways their credibility and authority as informants were rooted in direct experience of the unfamiliar and the accumulated experience, or expertness, that this and their wider experience generated. Yet, whilst not undermining the significance attached to seamen in the 'Directions', we should approach them with caution when considering their wider distribution and use. Some historians and literary scholars have celebrated the 'Directions' as an epistemic tool that 'mold[ed] the sea journal into a product that would increasingly meet the Royal Society's requirements.'[48] However, the standardization of log books in the late-seventeenth and early-eighteenth century was less a result of the 'Directions', than part of a simultaneous development within the naval administration for more useful, accurate information as logbooks gradually became more systematized across early modern Europe. By the 1660s, the admiralty was already requesting that captains keep 'a true and exact journal of their proceedings', while chartered companies, such as the East India Company had required 'a journal of each days navigation' from the beginning of the century.[49] Furthermore the absence of any references to observational 'diaries' received as part of the initiative, as well as Hooke's continued comments on the need for seamen's observations to be 'retained and preserved' suggests that the 'Directions' serve as a statement of the institution's vision for the participation of seamen in information-gathering, rather than plain evidence of their involvement.[50] The 'Directions' were almost predicated on a notion of a boundless, omnipresent seaman who, unshackled by his occupational duties and the physical demands of seafaring, could collect, record and measure at every opportunity across time and space. Aside from these practical challenges, Hooke also identified the problem as a lack of 'public encouragement' to enforce compliance with the 'Directions' and ensure the preservation of useful travel accounts. He argued that the Royal Society had delivered in 'preparing and dispersing instructions to this end', but this could only prove productive 'if the Publick would allow a Recompence to the Undertakers', who were in need of some 'moderate encouragement and reward.'[51] This was far

[47] 'Directions for seamen, bound for far voyages', *Philosophical Transactions* 1 (1665), pp. 140-3.

[48] Kelly, 'Bordering on Fact in Early Eighteenth Century Sea Journals', p. 165 (note 25); Pearl, 'Geography and Authority in the Royal Society's Instructions for Travelers', p. 71 (note 28).

[49] Margaret Schotte, 'Expert Records: Nautical Logbooks from Columbus to Cook', *Information & Culture: A Journal of History* 48, no. 3 (2013): 281-322, 294. Also see the numerous instructions to naval captains in The National Archives (TNA), London, ADM 2. Non-maritime parties had also started seeking the collection of maritime particulars; in 1633, thirty years before the 'Directions', the mathematician William Oughtred called for masters and pilots to record information 'diligently and faithfully' and 'take paines in the journals of their voyages' (William Oughtred, *An addition unto the use of the instrument called the circles of proportion*, [London: 1633], p. 55).

[50] In the Society's minutes, it was further suggested that an order be obtained from the Duke of York that would require every captain and master of a ship to carry a copy of the 'Directions' on board. However, just like the observational diaries, this order does not appear to have materialized (RS, JBO/3, ff. 36-7, meeting minutes, November 7 1666).

[51] Hooke, in Knox, *An Historical Relation of Ceylon*, preface (note 26).

apart from the financially disinterested gentleman philosopher that Shapin has spoken of. To Hooke, and to Wallis, financial incentive or occupational interest did not compromise the faithful recording of observations or the credibility of informants. To the contrary, it strengthened it. Hooke stood as a powerful counter-example to this himself as salaried member of the Royal Society, while René Descartes in his *Discourse on Method* also suggested that the payment of artisans to conduct experiments and observations might actually ensure accuracy given the power of their pecuniary interest.[52]

Accumulated experience and the expert mariner

Experience, as we have seen, was fundamental to notions of expert. It was entwined with estimations of a person's knowledge and skill that had developed through continued exposure and practice. The image of a skilled, competent seaman, however, competed with a pejorative stereotype of him as ill-educated, ill-equipped, and ill-mannered.'[53] Many gentleman philosophers subscribed to the stereotype of the unruly, ignorant seaman, framing some of their maritime inquiries as a response to what they saw as the 'erroneous and idle' state of the seaman's knowledge. Yet there was clear distinction made between the ignorant seaman and a superior caste of seaman - the masters and pilots of the 'Directions - who were more knowledgeable and more expert than the common multitude. This binary is clearly reflected in the writings of John Flamsteed, the first Astronomer Royal, who distinguished those seamen who 'had needless fears of breaking their backs with the burdens of unnecessary knowledge' from those 'very ingenious persons among them, capable of the depth of knowledge.'[54] There still existed a hierarchy of seamen within the experimental community, but this corresponded to the skill and experience of the seaman, rather than his status, civility or perceived disinterestedness. In his navigational treatise *The Mariner's Magazine* (1669), Samuel Sturmy similarly contended that navigation was 'daily practiced by expert seamen: but much abused by hundreds of ignorant asses.' Sturmy, like many others, pitted the expert against the ignorant, seeing the 'expert seaman' as a product of the union of 'theorick' and 'practick.'[55]

Sturmy himself was an example of the 'expert' seamen, who received recognition for the value of his direct and accumulated experience, a web of skill and prior knowledge that informed singular, empirical observations. He may have been the master of a merchant vessel, but he had a rather modest background. The son of a grocer, apprenticed to a sail maker, he was, as most merchant captains, a tarpaulin, not a gentleman, and his rank as master was a sign that he was an *experienced* seaman, but a seaman nonetheless.[56] In a letter of introduction to Oldenburg, John

---

[52] René Descartes, *Discourse on Method* (Leiden: 1637), part 6.

[53] Early in the seventeenth century, Samuel Purchas made the poetic comparison between the temperament of the seaman and the nature of the seas he crossed, remarking that their 'manner seems roughhewn and rude, according to the Ocean that breeds him' (Samuel Purchas, *Purchas His Pilgrimage* [London: 1626], p. 487).

[54] Flamsteed to Pepys, 21 April 1697, in Forbes, Murdin, Wilmouth (eds.), *The Correspondence of John Flamsteed*, vol. 2 (London: IOP Publishing, 2002), p. 636-8. The original is held at Pepys Library, Cambridge, MS 2184, ff. 1-24. There is also a copy of an extract of the letter in the British Library (BL), Add. MS. 30221.

[55] Samuel Sturmy, *The Mariner's Magazine*, p. 3.

[56] This was abundantly clear to John Beale, who wrote a note to Oldenburg at the bottom of one of Sturmy's manuscripts: 'it will be necessary before this be published, to correct the English all along, to shape it into true writing allowing in due places the seaman's language' (RS, Cl.P/6/24, 'An account from Bristol of some observations made by Capt Samuel Sturmy', 12 October 1668).

Beale introduced Sturmy's work on magnetic variation and the tides, which were natural phenomena that Sturmy, as a seaman, had the opportunity to observe first-hand. Beale recorded the circumstantial detail surrounding Sturmy's observations (where it was observed and in whose presence), harnessing and disciplining Sturmy's experience to make it epistemically serviceable. This was typical of observational reporting, for it facilitated a form of 'virtual witnessing' by recreating personal experiences through literary form.[57] This added credence to Sturmy's observations, but his overall credibility was compounded by his perceived 'expertness' in maritime affairs. Central to Beale's presentation of Sturmy was the fact that he 'hath beene used to ye sea from his childhood, and was many yeares a commander of a merchant ship.' When Sturmy's observations were published, he was described as an 'experienced seaman', which signaled a level of know-how on the subject that others were unlikely to possess.[58]

Expert seamen like Sturmy became an essential part of the Royal Society's intelligence networks. Following Beale's introduction, Oldenburg published Sturmy's tidal observations in the *Philosophical Transactions* and his data was also used to calculate the precession of the equinoxes in the third book of Newton's *Principia Mathematica*, forming – as Simon Schaffer has shown - a key part of the global information order that underpinned Newton's work.[59] However, despite the best efforts of its propagandists, we should be careful that this not give way to an impression of the Royal Society as an egalitarian institution 'settled of many eminent men of all Qualities.'[60] Here we must distinguish the Royal Society as a social institution from the general investigative activities that it initiated or promoted. What is perhaps most interesting about Beale's letter is that, following his positive endorsement of Sturmy, he moves to separate him from the fellowship: 'I shall give you caution,' he wrote, 'I do not recommend Captain Sturmy, as worthy to be of the Royal Society, but as worthy to have some good countenance & encouragement for his industry & heartiness.'[61] There was a high prestige attached to the fellowship, and fellows were often admitted for the status they carried and, as a result, also conferred on the Society. Yet the social make-up of the fellowship was not indicative of the range of individuals involved in its associated modes of inquiry. Beale appears to observe this distinction when he recommends that, while Sturmy was not worthy 'to be *of* the Royal Society', he was worthy to receive some 'countenance and encouragement' from them. Certain codes of civility may have animated the *social* life of experimental philosophy, but that does not mean they dictated epistemic practice. Dampier and Knox, for instance, may have been invited to participate in the formalities of the Royal Society at meetings and dinners, but it was ultimately their experience that had enabled them to report and discourse on the natural world.

Boyle's body of work offers the most abundant examples of the variety of seamen involved in the supply of maritime information, showing how he fashioned the seaman's credibility on the basis of their accumulated experience of the maritime world. He used the testimony of seamen

---

[57] Shapin, 'Pump and Circumstance', pp. 481-520 (note 36).

[58] 'An extract of a letter, written by D. B. to the publisher, concerning the present declination of the magnetick needle, and the tydes,' *Philosophical Transactions* 3 (1668): 726-7.

[59] Isaac Newton, *Principia Mathematica*, (London: 1687), Book III, Proposition XXXVII; Simon Schaffer, 'Newton on the Beach: The Information Order of Principia Mathematica', *History of Science* 47 (2009): 243-76. For his theory of the tides, Newton also derived information from observers who travelled 'the great South-sea along the Coast of China' and 'the Indian-Sea, along the Coast of Malacca and Cambodia' (see 'The True Theory of the Tides' in *Miscellanea Curiosa*, vol. 1, pp. 22-5 [note 32]).

[60] Thomas Sprat, *The History of the Royal Society* (London:1667), p. 431.

[61] RS, EL/B1/53, Beale to Oldenburg, 23 May 1668.

in three particular forms: direct, oral testimony; second-hand testimony; and written testimony. Within Boyle's classification system, these were all forms of historical experience, relations or testimonies that had been personal in another man.[62] Writing in 'Relations about the bottom of the sea', he criticized naturalists who relied on 'hearsay' and proudly recited what he had learned from 'many navigators and travelers I have had opportunity to converse with', especially those who 'were the likeliest to give me good information about these matters.'[63] To Boyle, the 'likeliest' were those seamen with notable skill and experience: an 'ancient and expert seaman', 'an ancient navigator who passes for the most experienced pilot in our nation for a east India voyage', 'a sea captain of extraordinary skill', 'an ancient sea-commander that had many years frequented Africa and India.' Here, a seaman's designation as 'ancient' signaled his level of experience, and was considered a reasonable indicator of his knowledge and trustworthiness. It was 'reputation' that made Boyle 'endeavor to have a little conference with [men] about the subject.'[64]

To Boyle, it was the accumulated experience of maritime observers that indicated their credibility, not their rank or status per se. Although the seamen employed by Boyle tended to be of a higher rank, this served to reinforce their expertness, rather than their credibility alone. In fact, in one particular instance where a sea captain was of high birth, Boyle presented him not as a seaman, but as a gentleman; 'having the honour to discourse with a nobleperson who has divers times deservedly had the command of English fleets.'[65] We could then reasonably suppose that other pilots, navigators and captains that Boyle encountered were often of modest backgrounds unless stated otherwise: nobleman or nobleperson being the appropriate term for a gentleman captain. In 'New Experiments and observations touching the Cold', Boyle made heavy use of the observations of Captain Thomas James, stressing that 'by [James'] breeding in the university, and his acquaintance with the mathematics, he was enabled to make far better use [of the opportunity to observe] than an ordinary seamen would have done.'[66] James' breeding in the university was not used as social signifier, but as an indicator of his wider knowledge and skill, for competence in mathematics was regarded, as we shall see, as a key requisite for the expert seaman. There was a general preference for reporters who were both curious to explore the natural world and, like Captain James, knowledgeable enough to report on it. Boyle emphasized these qualities in his own informants, writing of a 'famously inquisitive navigator', 'some navigators of the most conversant in the [subject of the] cold' 'a navigator very curious of celestial observations' and 'a great commander at sea, who has both an extraordinary curiosity, and an unusual care in making observations.'[67]

By integrating seamen's testimony into his own writing, Boyle vouched for their credibility, which he located in estimations of the seaman's expertness. There was a degree of selectivity to Boyle's use of the testimony of others, but this was often based on how far testimony could be explained via contemporary mechanical or scientific principles over any other factor. In some cases, Boyle was mindful of the potential skepticism of his readers, pre-empting their incredulity by addressing the apparent 'strangeness' of relations, while simultaneously seeking to reaffirm

[62] Robert Boyle, *New Experiments and Observations Touching the Cold* (London: 1665), p. C7r.
[63] Boyle, 'Relations about the bottom of the sea', *Works,* vol. 3, p. 349 (note 11).
[64] Boyle, 'Relations about the bottom of the sea', *Works*, vol. 3, pp. 350-3 (note 11).
[65] Boyle, 'Relations about the bottom of the sea', *Works,* vol. 3, pp. 351 (note 11).
[66] Boyle, *New Experiments and Observations Touching the Cold*, preface (note 60).
[67] Boyle, 'The Experimental History of the Cold', *Works,* vol. 2, p. 554, 576, 604; Boyle, 'Relations about the bottom of the sea', *Works,* III, pp. 353-4 (note 11).

their credibility. In 'The Experimental History of the Cold', he did this in two ways: firstly, by multiplying seamen's testimony 'to keep them by their mutual support, from being entertain'd with a disbelief' and secondly, by reconciling their testimony with his own theoretical framework. 'As for the other newly mention'd relations of Seamen and Travellers', Boyle wrote:

> though to us, that live in England, they cannot but seem very strange; yet I am kept from rejecting them as utterly incredible, by considering, that ice and snow having before their Congelation been water, must in probability owe their Coldness, to that which reign'd in the Air.[68]

Even within the margins of the 'strange', Boyle demonstrated a readiness to accept and appropriate seamen's testimony, especially when they could be accommodated by existing modes of thinking. The 'writings or verbal Relations of Navigators and Travellers' became a significant component of his investigative methodology, which he would 'subjoin' with information he had gathered from his own experiments.[69]

Seamen provided supplementary experience to the experimental philosopher's; their experience could confirm existing ideas, fill the gaps, and enlarge the pool of natural knowledge. Even those philosophers with more direct experience of the seas than Boyle reserved a space for the testimony of seamen, pointing to the value of their experience even alongside parallel claims to maritime expertise. Halley, for instance, who voyaged to St Helena in the 1670s and into the South Seas in the late 1690s, made great use of accounts 'by our seamen', specifically the 'accounts of East-India and Guinea Navigators.' In fact, he argued that their testimony was necessary 'so that what I have here Collected may be either confirm'd or amended, or by the addition of some material circumstances enlarge'd.' On subjects such as the trade winds, Halley felt able to challenge and rectify existing accounts, as well as his own, by virtue of the conversations he had with numerous navigators.[70] As the 'Directions' illustrated, any 'complete and perfect' theory required high numbers of observations in order for information to be compared, collated, and consolidated and for conclusions to extend from the local to the global.

However, seamen did more than collect raw data, their interpretation and judgement were valued too. In *Voyage to Jamaica* (1707), we see Sloane repeatedly seek further information from seamen on marine birds, animals, and fish. Seamen developed their own nomenclature for the species they encountered at sea, which was often shaped by their own experience: the 'man of war bird' in the West Indies, for instance, was said to foretell the coming of a ship, while the 'caravel' jellyfish was so-called for it resembled the sails of the Portuguese man-of-war. Sloane variably adopted these terms in *Voyage to Jamaica*, or replaced them with a more formal, Latinised nomenclature of his own.[71] Like Boyle, he interweaved seamen's experiences and descriptions with his own and with many other printed accounts. After citing the work of Richard Hakluyt and Jean de Léry (maritime explorers not naturalists) on the 'caravel' jellyfish, for example, Sloane described his own experience of the creature, proceeding to explain that the

---

[68] Boyle, 'The Experimental History of the Cold', *Works,* vol. 2, pp. 557, 615 (note 11).
[69] Boyle, 'The Experimental History of the Cold', *Works,* vol. 2, pp. 530, 605 (note 11).
[70] Edmond Halley, 'An Historical Account of the Trade-Winds and Monsoons observable in the Seas between and near the Tropicks', in *Miscellanea Curiosa*, vol. 1, pp. 61, 65, 71, 73 (note 32).
[71] Hans Sloane, *A Voyage to the islands Madera, Barbados, Nieves, S. Christophers and Jamaica* (London: 1707), pp. 7, 30, 31.

'seamen do affirm that [jellyfish] have great skill in sailing, managing their bladder or sail with judgement, as may be most for their purpose, according to their different winds and courses.'[72] The seamen's descriptions were useful and authoritative, providing the necessary supplementary information to corroborate and expand existing knowledge.

Sloane had direct access to the opinions of seamen throughout his voyage to Jamaica and his account provides a snapshot into the working relationships between himself and the crew.[73] He documented a particularly interesting encounter whereby a seaman from the upper deck brought him a large grasshopper, which had fallen from the rigging of the ship. The seaman was clearly aware of Sloane's interest in natural history and was sufficiently engaged with the subject to consider the incident 'strange' and worthy of the naturalist's attention. This individual act by the seaman, delivering the grasshopper to Sloane, set in motion a line of inquiry that can be traced in Sloane's account of the exchange in the *Voyage to Jamaica*. Sloane inquired into the appearance of the grasshopper 'a very great way from land', hearing from the rest of the crew that they had also seen these insects fly through the rigging and, once ashore, from Rear Admiral John Narborough, 'a very experience'd and observing person', who had also observed the same. He proceeded to describe the anatomy of the grasshopper in great detail and cross-referenced this occurrence with other printed accounts, such as Purchas and the Dutch admiral, Steven van der Hagen.[74] Sloane was open to seamen's notions and judgements, attempting to fit their knowledge into contemporary configurations of the natural world. This is particularly clear in his treatment of explanations for the 'sparking light of seawater', which continually perplexed him. The seamen had reported to Sloane that this phenomenon was most commonly observed in 'southerly winds than any other'; 'how true I know not,' he replied, 'but am sure the more the sea is broken or white, the more you see of them.' Sloane posited that the 'sparking' proceeded from 'the small corrupted parts of fish' floating near the surface of the water, but he sought to reconcile these thoughts with the ideas of the seamen, commenting that 'the relation of seamen may well enough agree with this, the south winds being warmer and more promoting of putrefaction.' Sloane chose not to reject the seamen's theory on the incidence of 'sparkling' in southern winds, instead using them to reinforce his own conclusions on putrefaction, for reconciliation added credence to both sets of ideas. If Sloane's ideas were considered 'unreasonable', he offered his readers 'the relations of several seamen' who could assent to the accuracy of his own assertions; seamen having 'sailed a great many hours through Fishes spawn; I myself have so for more than two days.'[75] In this instance, the relationship was almost symbiotic, for while Sloane vouched for the integrity of the seamen's testimony, the breadth of their experience reinforced Sloane's own notions too.

Boyle, Halley, and Sloane's work shows clear recognition of the seaman's expertness and their authority to speak on the natural world. This cannot be said to reflect on all seamen, of course;

---

[72] Sloane, *A Voyage to Jamaica,* pp. 7-8 (note 69).

[73] Sources that document the relationship between fellows of the Royal Society and seamen on-board ships are scarce; however, John Clayton, Rector of Wakefield and FRS, relates an incidence when the captain of a ship bound for Virginia consulted him about the cause of a leak in the ship, after failing to identity it himself and with the help of his crew ('A letter from Mr John Clayton,' *Philosophical Transactions*, no 201, [1693]: 781-95).

[74]Sloane, *A Voyage to Jamaica,* p. 29 (note 69). In other cases, there was an obvious commercial motive for seamen to collect natural specimens - on a journey to Constantinople, one FRS experienced a seaman attempting to catch a hawk that 'he hoped to have made money of at the next port' (Thomas Smith, 'A Journal of a Voyage from England to Constantinople,' *Philosophical Transactions* 19 [1695]: 597-619, 600).

[75] Sloane, *A Voyage to Jamaica,* p. 6 (note 69).

as with the Directions, those consulted were often noted for their skill and knowledge, for being particularly expert (though in the absence of distinguished expertise seamen could be credible in number). What is particularly notable from these accounts is that these seamen did not only collect and provide reliable information, some – like Sturmy or the group of seamen Sloane encountered - also offered valuable interpretations of such phenomena. We acquire an even firmer sense of the seaman's interpretive faculty if we turn to the case of the Royal Mathematical School, which was established at Christ's Hospital by Charles II in 1673 to prepare young boys for sea. In the 1690s, Pepys solicited the opinion of a number of prominent mathematicians and astronomers on the school's curriculum. Lamenting the current state of the common seaman's knowledge, proposals from Flamsteed, Newton and Halley all sought to convert the ignorant seaman into the expert through a greater acquaintance with theory, going beyond the 'Directions' by elevating seamen as interpreters as well as observers of nature. The new proposals were 'not designed to give them only so much learning as is barely thought necessary for a plain Saylor... but that it is intended to have them instructed fully in all the skill that is requisit in an Accomplished Navigator'. The apprentice seaman would be trained in trigonometry, algebra, and map projection, become 'acquainted with the stars' and well-versed in 'mechanical powers'; they were not to be instructed in 'blind practical things, but required to know 'the true reason of what they do.'[76]

The young apprentices had been selected from a 'great multitude', but were all drawn from poor backgrounds (Christ's Hospital being one of the largest charity schools in London). The boys' potential as both skillful mariners and learned observers was therefore aligned with their education, not status, and the skills cultivated as a result of this. The dual function of their education was clear, for enhanced training would not only lead to improved maritime practice, but create a larger community of expert mariners who could more readily provide accurate observations and synthesise these for the use of experimental philosophy. Flamsteed, for instance, wrote that:

> If proper methods be taken in teaching [seamen]...they would contrive instruments much more convenient for taking the heights of the sun or stars aboard a ship...they would bring you home the latitudes of the ports in which they harbour'd... they would be able to make observations of the moon or satellite eclipses in any port...[to compare] with those made at the Greenwich observatory.

Seamen were to work alongside experimental philosophers, comparing lunar observations to 'give us the true longitude of those ports' that would allow for the correction of 'the faults of our present maps and sea charts.'[77] Halley had previously censured seamen for failing to make sufficient observations of coasts, ports, and points of longitude as they had opportunity to. 'Tis

---

[76] Flamsteed to Pepys, 21 April 1697, in *The Correspondence of John Flamsteed*, vol. 2, p. 639-41 (note 52); Isaac Newton to Nathaniel Hawes, May 25 1694, in J. Eddleston (ed.) *Correspondence of Sir Isaac Newton and Professor Cotes,* (London: Frank Cass & Co. Ltd, 1969), p. 282. Discussion regarding the education of young seamen was tied up with the election and requisites for a new mathematical tutor at the Royal Mathematical School. For more on this, see Rob Iliffe, 'Mathematical Characters: Flamsteed and Christ Hospital's Royal Mathematical School', in Francis Willmouth (ed.) *Flamsteed's Stars: New Perspectives on the life and works of the First Astronomer Royal* (Woodbridge: Boydell Press, 1997), pp. 115-44, and Francis Wilmouth, *Sir Jonas Moore: Practical Mathematics and Restoration Science*, (Woodbridge, Boydell Press, 1993).

[77] Flamsteed to Pepys, 21 April 1697, in *The Correspondence of John Flamsteed*, II, p. 638-9 (note 52).

their own fault,' he wrote 'that they do not collate their several experiments, and bring them into a general synopsis which would be much for their own and the public service.' The problem was not that they had failed to collect observations, but that they had failed to do anything with them. From this perspective, the seamen's desired role extended beyond a collector of information, to an analyst of the information he gathered. Halley wanted seamen to bring their observations, experiments and experience into a general synthesis, to establish patterns or even laws of nature. On the matter of tides, for instance, he recommended that seamen should 'compare and bring together their experience of the course of the tides, so as reduce them under some general rules.'[78] In this new scheme of learning, the seaman was expected to understand the causes of things, the theories that underwrote their practice, and to essentially behave in the way of the philosopher.

In many ways, seamen embodied the authority of experience in early modern science, fashioned as Columbian-inspired informants and interpreters who were 'eye witnesses and ministers of the things they speak of.' Not only did their authority derive from the novelty and remoteness of the things they witnessed, but from the cumulative effect of these and a myriad of other experiences. Frequent practice, observation and exposure could generate a form of expertness that rendered them credible and authoritative in an alternative hierarchy of observers and thinkers. The gentlemanly trust model does not accommodate nor acknowledge the ways the seamen's direct and accumulated experience were recognized, and indeed valued, in inquiry and discourse. The Royal Society sought to collect, publish and disseminate the journals of numerous seamen like Dampier and Knox and set out to recruit a whole network of expert navigators to amass information from across the globe. Experimental philosophers and naturalists like Boyle and Sloane solicited, weighted, and printed the judgement of seamen alongside their own and, within the same socio-intellectual circles, Flamsteed, Newton and Halley championed a vision of the expert seaman who, through greater theoretical training, could be molded in the image of the experimental philosopher. Symbolic of the overlapping worlds of science, seafaring, and government, William Petty, as Judge of the Court of Admiralty in Dublin, celebrated the knowledge of seamen; they brought 'intelligence from all parts of the world', they were concerned with the 'motion of the heavenly bodies' and they saw the 'wonders of God in the deep.' Although many in their current state of knowledge remained ill-equipped, as Petty would come to find, at least in theory, they 'ought to be the best and most practical philosophers.'[79]

Historians should now begin to consider whether the experience of all manual workers was treated in the same way. The authority of one group cannot be seen to reflect on another and we should consequently pay greater attention to the make-up of expertness in different professional groups, rather than reducing their knowledge and skill to generic notions of *techne* and bodily knowledge. Whether concerned with production (*poiesis*) or action (*praxis),* each group, from miners to goldsmiths, husbandmen to clock-makers, cultivated their own specialized sets of skills, knowledge and experience that the experimental philosopher could utilize. Expertise thus stands as an important entry point into understanding trust, credibility and authority in early modern science. It brings us beyond a restrictive mono-model that locates trust in one socio-cultural

[78] BL, Add. MS 30221, f. 85, 'Mr Halley to Mr Pepys touching the yet Imperfect Measure of knowledge in our Ordinary Navigators', February 17 1695-6. The original manuscript is held in Pepys Library, Cambridge, MS 2185.
[79] BL, Lansdowne MS. 1228/7, f. 42, 'Sir William Petty's speech at his first sitting as Judge of the Admiralty', April 2 1676.

category and allows us to appreciate the multiple, and sometimes competing, claims to epistemological authority.